

# Claims

[c1] What is claimed is:

1.A lumped-element transmission line formed in a multi-layered substrate comprising:  
a first inductor;  
a second inductor electrically connected to the first inductor in series at one end, wherein the first and second inductors are spiral in shape and the orientations of the first inductor and the second inductor are the same so that the spirals progress in the same sense such that a mutual inductance between the first and second inductors is positive and equals a first value; and  
a first capacitor wherein a first end of the first capacitor is electrically connected to ground and a second end of the first capacitor is electrically connected to the end of the second inductor at which the second inductor is connected to the first inductor.

[c2] 2.The lumped-element transmission line of claim 1 wherein the first inductor is formed on a fourth layer of the multi-layered substrate, the second inductor is formed on a third layer of the multi-layered substrate and is electrically connected to the first inductor in series

through a first via penetrating the substrate, and the first capacitor comprises two plates formed on a second layer and a first layer of the multi-layered substrate, in which the plate formed on the second layer is connected to ground and the plate formed on the first layer is connected to the first via.

[c3] 3.The lumped-element transmission line of claim 2 wherein the first capacitor is shunt-connected to a second capacitor which comprises two plates formed on a fifth layer and a sixth layer of the multi-layered substrate, in which the plate formed on the fifth layer is connected to ground and the plate formed on the sixth layer is connected to the first via.

[c4] 4. The lumped-element transmission line of claim 3 wherein the first and second capacitors sandwich the first and second inductors.

[c5] 5.The lumped-element transmission line of claim 1 wherein the first inductor is formed on a second layer of the multi-layered substrate, the second inductor is also formed on the second layer and electrically connected to the first inductor in series at an end, and the first capacitor is formed on a first layer of the multi-layered substrate, in which the first layer is next to a ground plane and is connected to the end of the second inductor at

which the second inductor is connected to the first inductor through a first via penetrating the substrate.

- [c6] 6. The lumped-element transmission line of claim 5 wherein the first capacitor is shunt-connected to a second capacitor which is formed on a fourth layer of the multi-layered substrate, in which the fourth layer is next to another ground plane, and is connected to the first via.
- [c7] 7. The lumped-element transmission line of claim 6 wherein the first and second capacitors sandwich the first and second inductors.
- [c8] 8. The lumped-element transmission line of claim 1 wherein the multi-layered substrate is a low temperature co-fired ceramic (LTCC) substrate.
- [c9] 9. The lumped-element transmission line of claim 1 wherein spirals of the first and second inductors are rectangular, circular, or octagonal in shape.
- [c10] 10. The lumped-element transmission line of claim 1 wherein the first value is according to an applied frequency range and values of the first inductor, the second inductor, and the first capacitor.
- [c11] 11. The lumped-element transmission line of claim 1

wherein the first value is according to shapes of and relative distance between the first inductor and the second inductor so that the mutual inductance equals the first value.

[c12] 12. The lumped-element transmission line of claim 1 wherein at least one inductor is formed on a plurality of layers of the multi-layered substrate.

[c13] 13. The lumped-element transmission line of claim 1 wherein the capacitor comprises a plurality of plates formed on a plurality of layers of the multi-layered substrate.